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Editorial

Continental reconstruction and metallogeny of the Circum-Junggar areas and termination of the southern Central Asian Orogenic Belt

Continental reconstructions in Central Asia are represented by orogenesis along some large orogenic belts in the Altaid collage (Fig. 1) or Central Asian Orogenic Belt (CAOB), which separate the East European and Siberian cratons to the north from the Tarim and North China cratons to the south (Şengör et al., 1993; Jahn et al., 2004; Windley et al., 2007; Qu et al., 2008; Xiao et al., 2010; Xiao and Santosh, 2014). The Altaid Collage was characterized by complex long tectonic and structural evolution from at least ca. 1.0 Ga to late Paleozoic–early Mesozoic with considerable continental growth (Khain et al., 2002; Jahn et al., 2004; Xiao et al., 2009, 2014; Kröner et al., 2014), followed by Cenozoic intracontinental evolution related to far-field effect of the collision of the Indian Plate to the Eurasian Plate (Cunningham, 2005). Accompanying with these complex geodynamic evolutions, many world-class ore deposits developed (Qin, 2000; Yakubchuk et al., 2001; Goldfarb et al., 2003, 2014).

Numerous studies have been carried out on this complex tectonic system and its associated metallogeny in some key tectonic belts (Briggs et al., 2007; Safonova et al., 2009; Han et al., 2010; Kröner et al., 2010; Lehmann et al., 2010; Safonova and Santosh, 2014). Two end-members of major tectonic views have been proposed about the orogenic style and continental construction of the Altaid Collage; one group of scientists consider that the Altaid collage was formed by amalgamation of multiple terranes (Mossakovsky et al., 1993), whereas others proposed that there was only one continuous accretion along a single arc chain (Şengör et al., 1993; Yakubchuk et al., 2001).

Solving the controversy is not an easy task. The international community has focused considerable attention on this region and in 2013, the tectonics of the southern Central Asian Orogenic Belt was among the top research fronts in earth science. However, several fundamental problems related to the tectonic style of the Altaid collage remain to be solved, such as the tectonic settings and ages of some key components and their contributions to the final continental construction, together with their control on the formation of mineral deposits. Among these, the tectonic settings and deformation features of orogenic components around the Junggar Basin have been one of the hottest topics in recent research. Some scholars thought that the Junggar terrane underneath the Junggar Basin might have been a continental block (Qu et al., 2008; Choulet et al., 2011), thus any orogeny between the Altai, Tianshan and the Junggar terranes would have been regarded as continental collision or similar orogenic style with collision style. Therefore the Altaid was nothing more than a collage of multiple terranes. However, some other researchers pointed out that the Junggar terranes might have been composed of oceanic arcs and trapped oceans (Wang et al., 2002; Xiao et al., 2008). Therefore the orogenic belts surrounding the Junggar terrane might have been one phases of the long-lived, continuous multiple accretionary orogenesis (Windley et al., 2007; Xiao and Santosh, 2014).

In association with those problems is the final amalgamation history of the southern Central Asian Orogenic Belt, which has been also controversial with contrasting models. There have been many different views about the final amalgamation time of the Altaid collage, varying from the Devonian, to Carboniferous and Permian–Triassic (Han et al., 1997; Gao and Klemd, 2003; Windley et al., 2007; Xiao and Santosh, 2014). It seems reasonable that the final orogeny was terminated in the Carboniferous if we accept that the Junggar terrane was a rigid continental block. However, if we consider the trapped ocean nature of the Junggar terrane, the accretionary orogenesis might have not been terminated after any amalgamation events between these terranes.

Our aim of this special issue of *Geoscience Frontiers* is to present the compilation of multidisciplinary papers that contain new data and ideas to help constrain the tectonic evolution of the Junggar areas and some key components regarding the continental reconstruction of the Altaid collage and its metallogeny. These papers constrain new, unpublished data and ideas that provide some constrains on the evolutionary history and its related mineralization (Fig. 1). Tectonically, these papers cover the western and eastern parts of the Altaids.

West Junggar occupies a key tectonic position in the Altaid collage (Fig. 1). Deng et al. (2015) presented systematic studies of mineral chemistry, whole-rock major and trace element compositions for the Tuerkubantao mafic-ultramafic intrusion of the West Junggar orogenic belt. The Tuerkubantao mafic-ultramafic intrusion is a well-differentiated complex comprising peridotite, olivine pyroxenite, gabbro, and diorite, which displays many similarities with Alaskan-type mafic-ultramafic intrusions along major sutures of Phanerozoic orogenic belts. They further propose that subduction of the oceanic slab has widely existed in the expansive oceans during the Devonian around the Junggar block.

Li et al. (2015) reported new whole-rock major and trace elements, and zircon U–Pb and Hf–Nd isotope compositions for the Karamay dikes, enclaves, and host granites in the West Junggar, NW China. They propose that in the latest Carboniferous–earliest Permian the upwelling mantle through a slab window in an island arc

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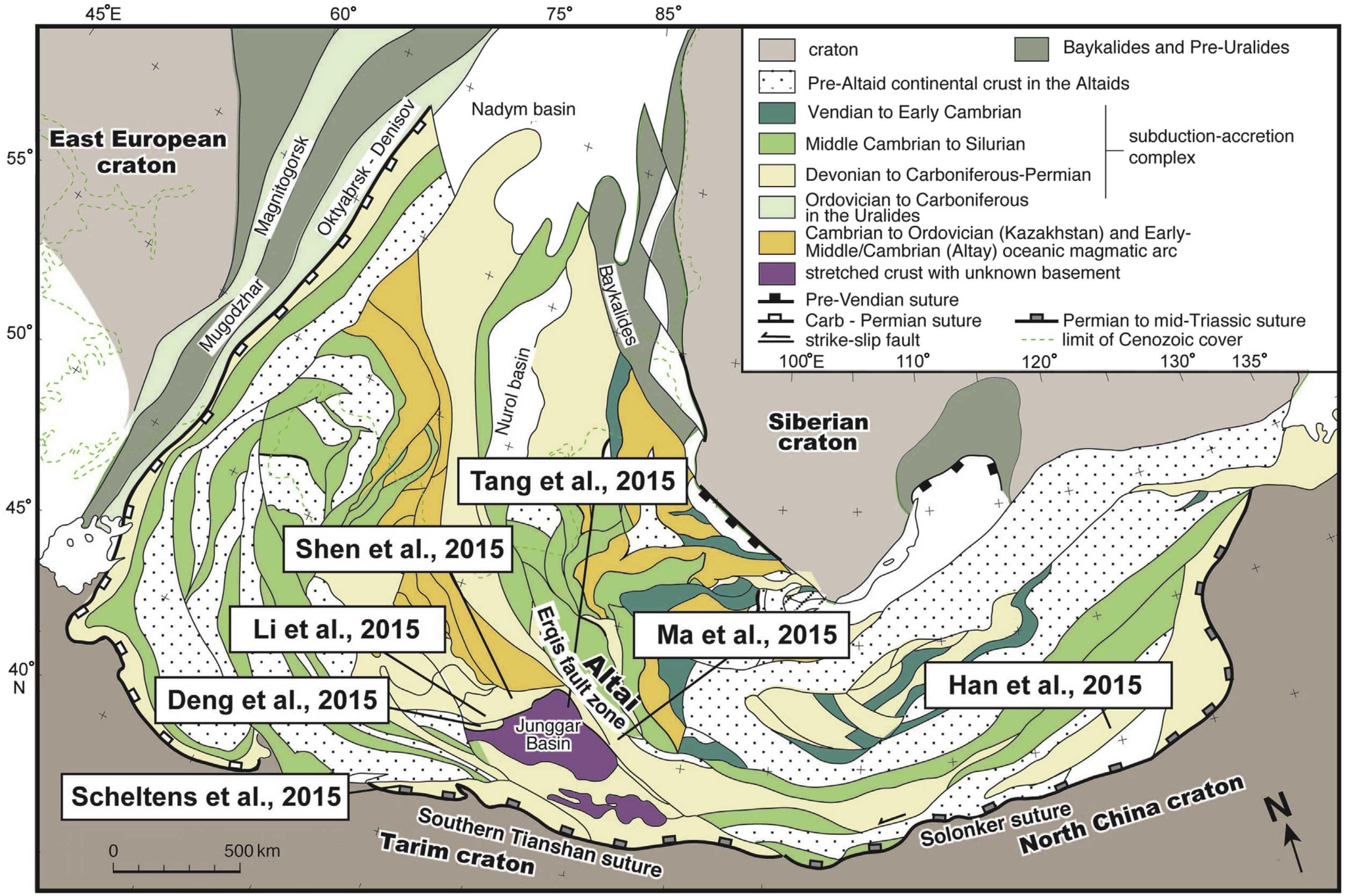

Figure 1. Simplified tectonic map of the Altaids (Modified after Sengör et al., 1993; Xiao et al., 2008).

environment might have triggered partial melting of the lithospheric mantle and its subsequent interaction with the granitic magma, further suggesting that the ridge subduction played an important role in the crustal growth of West Junggar.

Shen et al. (2015) summarized three metallogenic belts distributed systematically from north to south in West Junggar, hosting a number of deposits belonging to at least eight economically important styles, including epithermal Au, granite-related Be-U, volcanogenic massive sulfide (VMS) Cu-Zn, podiform chromite, porphyry Cu, hydrothermal quartz vein Au, porphyry-greisen Mo(-W), and orogenic Au. Five tectonic-mineralized epochs can be recognized, including the oldest Ordovician subduction-related VMS Cu-Zn deposit, to the youngest late Carboniferous to early Permian subduction-related porphyry-greisen Mo(-W) and orogenic Au deposits.

In relation to the final amalgamation event along the southern Altaid Collage, Scheltens et al. (2015) studied the major subduction polarity and the nature of accretion along the Chinese Tianshan, which is the western segment of the Altaid Collage (Fig. 1). Based on structural architecture of two of the main faults in the region, the South Tianshan Fault and the Nikolaev Line, they propose that subduction might have been northward rather than southward. The two shear sense directions, and a later dextral one with an age of 236–251 Ma, indicate that the Yili block was first dragged along towards the east due to the clockwise rotation of the Tarim block. After the Tarim block stopped rotating, the Yili block still kept going eastward, inducing the dextral shear senses within the fault zones.

Along the Tianshan-Solonker sutures to the east, Han et al. (2015) investigated the Linxi Formation which occupies an extensive area in the eastern Inner Mongolia in the Altaid Collage. Based on major and trace element data (including REE) for sandstones from the formation, and LA-ICPMS U–Pb dating of detrital zircons, these authors suggest that the main deposition of the Linxi Formation was at late Permain–early Triassic. Combining with previous results, they further suggest that the final collision of the Central Asian Orogenic Belt in the southern of Linxi Formation, which located in the Solonker–Xra Moron–Changchun suture, and the timing for final collision should be at early Triassic.

Mesozoic–Cenozoic intra-continental deformation is of importance to better understand the continental construction in Central Asia. Tang et al. (2015) presented the Mesozoic–Cenozoic deformation in the Wulungu Depression, the northernmost first-order tectonic unit in the Junggar Basin. By integration of fault-related folding theories, regional geology and drilling data, and the application of 2D-Move software, they postulate that the resurrection strength was slightly different, with the shortening rate being higher in the western segment than in the other segments. The authors further point out that the thrust fault mechanism is basement-involved combined with triangle shear fold, for which a forward evolution model was proposed.

Ma et al. (2015) investigated Carboniferous and younger strata identified through well data and high-resolution 3D seismic profiles in the Hala'alat Mountains located at the transition between the West Junggar and the Junggar Basin. On the basis of balanced sections, unconformities are determined to have been formed by erosion of uplifts or rotated fault blocks primarily during the Mesozoic and Cenozoic. These authors propose that the unconformities at the bases of the Permian Jiamuhe and Fengcheng Formations are most likely related to the subduction and closure of the Junggar Ocean during the late Carboniferous–early Permian; the unconformities at the bases of the Triassic Baikouquan and Jurassic Badaowan Formations are closely related to the late Permian–Triassic Durbut sinistral slip fault; the unconformities at the bases of the middle Jurassic Xishanyao Formation and Cretaceous Tugulu Group may be related to reactivation of the Durbut dextral slip fault in the late Jurassic–early Cretaceous.

The papers assembled in this special issue of *Geoscience Frontiers* provide a glimpse of the current research trends on the Altaid Collage. Although some lines of evidence and arguments presented in these papers support one school of thought, they do not provide a final solution to all the existing debates and problems. The tectonic settings and contributions of the Junggar terrane and its surrounding orogenic components, together with the final amalgamation events, are highly complex and need more systematic investigations. The controversy regarding the tectonic settings and termination of some key components probably will continue. However, we hope that the papers in this special issue of *Geoscience Frontiers* provide useful references for those who are engaged in studies related to the continental construction and metallogeny of the Altaid collage and/or Central Asian Orogenic Belt. We also hope that these studies would enthuse researchers to take up further investigations in unraveling the geological history and tectonic processes of Central Asia and surrounding regions.

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